Which signatures do matter for identifying and modelling critical zone processes of water and solutes transfert in headwater catchments

FOVET O[1*], RUIZ L [1]AND HRACHOWITZ M[2]

[1]INRA, AgroCampus Ouest, UMR SAS, Rennes, France (*correspondance : ophelie.fovet@inra.fr)

[2]Department of Civil Engineering, TU Delft, The Netherlands

Hydrological and hydrobiogeochemical models commonly aim at reproducing the response of streams to given input forcages (climatic, anthropogenic). The objective of the modeller, and thus of the calibration and assessment operations focused on mimicking the temporal output signal: the flow, a concentration, the product of both i.e. a load, or a relative abundance (δ for isotopic ratios). However, stream temporal signal are relatively poor for properly constraining process models, leading to disappointing predictive capability and equifinal parameterization resulting in poorly consistent model regarding to the internal catchment processes (Hrachowitz et al., 2014; Kirchner, 2006). Indeed, the output signal is oftenly used to infer catchment low-pass filter properties (the way it buffers and delays a variation in its input) whereas different processes are likely to produce the same output signals. Seasonal variations in stream concentration can be interpreted as the result of (i) seasonal variations in the input (precipitation) concentrations, (ii) seasonal switches in hydrological flowpathes (evapoconcentration, seasonal riparian contribution), or (iii) seasonal reaction processes. We claim that internal signatures are more relavant to characterize, identify and model the CZ processes. We present here a set of candidates based on observations and that include precipitation-storage (soil or groundwater), and storage-flow relationship in terms of volumes and concentrations. Then, we demonstrate on a synthetic experiment that different model structures can reproduce identical output signatures but differs according to those internal signatures.

Hrachowitz, M. et al., 2014. Process consistency in models: The importance of system signatures, expert knowledge, and process complexity. Water Resour. Res., 50(9): 7445-7469.

Kirchner, J.W., 2006. Getting the right answers for the right reasons: Linking measurements, analyses, and models to advance the science of hydrology. Water Resour. Res., 42(3): W03S04.